

REMARKS

The subject specification is directed to improvements in optically pumped semiconductor (OPS) lasers. In particular, the specification includes a fairly detailed discussion of the modifications which were made to the subject OPS lasers to increase the output power thereof. All the prior pending claims that were rejected by the Examiner included specific recitations of output power levels significantly higher than reported in the prior art. This difference was noted by the Examiner in the last office action. However, it was the Examiner's position that the two main prior art references (Rosiewicz and Alford) teach the same structural elements as being claimed. Absent a structural difference (beyond the power limitations), the Examiner would not allow the claims.

Although applicants do not agree with the Examiner's reasoning, in order to expedite prosecution, all the remaining claims have been amended to include some of the structural differences requested by the Examiner. With reference to the specification beginning on page 40, line 8 and carrying over to page 45, line 1, one important aspect for increasing output power is to increase the area on the OPS chip which is pumped by the pump light beam. In addition, this larger pump area should be coupled with a significant increase in the length of the resonant cavity. These changes cooperate together to allow the laser to operate at higher powers with stable, controllable modes.

Claims 45, 59, 70 and 73 have been amended to recite that the optical length of the resonator is at least five centimeters. Support for the five-centimeter limitation (as well as the 10-centimeter limitation of new claims 90 to 93) can be found in the specification at page 44, line 33. As recited on pages 43 and 44, the term "optical length" is intended to encompass both a physical length or an effective length which can be created by additional optics such as a telescope. Claims 45, 59, 70 and 73 have also been amended to specify a particular pump beam spot size at the OPS chip. Support for a spot size of 200 microns is found at page 34, line 11. Support for a larger spot size, having a $1/e^2$ radius of about 230 micrometers (i.e. a spot size of 460 microns) can be found on page 16, line 30. Claims 94 to 97 recite this larger spot size.

The principal prior art references relied upon by the Examiner related to optically pumped semiconductor lasers do not teach these limitations. The Rosiewicz article is silent regarding these parameters. The Alford article teaches a pump beam spot having an elongated shape with $1/e^2$ diameter of about 70 by 90 microns (third page of the article). The area covered

by a spot having a diameter of 200 microns (as set forth in the amended claims) is more than six times larger than the area of the beam spot specified by Alford (assuming an average radius of 40 microns). A spot size having a radius of 230 microns (as set forth in claims 94 to 97) has an area 33 times larger than that specified by Alford. Alford does not specify a cavity length. He does state that his doubling crystal is 7.5mm. In Figure 1 of Alford, it appears that the crystal occupies no more than one-half of the total resonator which would make Alford's resonator only about 1.5 centimeters in length.

The Kuznetsov paper discloses an OPS laser having a cavity length of 2 centimeters (see page 1064). Kuznetsov does not specify the size of his pump beam. However, he does mention the size of the laser beam on the chip, specifically, a ~115 micron diameter mode spot size. Those skilled in the art typically attempt to match the pump beam spot size with the laser beam spot size. In Kuznetsov, this matching is shown schematically in Figure 1, so it is likely that his pump beam spot size was at or near 115 microns. Although somewhat larger than Alford, the area of Kuznetsov's spot would still be three times smaller than the area of a 200 micron diameter spot as set forth in the amended claims. The Mooradian patent, as noted previously, appears to be merely a paper patent and has no disclosure of pump beam spot sizes or cavity lengths.

The secondary patents relied on upon by the Examiner are less relevant. The patents to Tsunekane, Liu, Selker and Holsinger merely relate to conventional solid state lasers. Deacon relates to non-linear conversion concepts and Shum was cited for its teaching related to heat sinks.

It should be noted that applicants have cancelled claims 53 to 58 to expedite prosecution. Claims 98 to 100 have been added to recite the preferred construction of the heat sink.

In summary, each of the claims 45, 59, 70 and 73 relate to optically pumped, semiconductor lasers and include not only specific power output levels well above that disclosed in the prior art, but also specific limitations regarding structural differences which the specification clearly describes as important for achieving these higher powers. It is believed that these amendments should overcome all of the objections raised by the Examiner with respect to

the claims. Based on the above, it is respectfully submitted that all of the remaining claims define patentable subject matter and allowance thereof is respectfully requested.

Respectfully submitted,

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